University of Pennsylvania

C. Bove, K. C. Chang, W. Giguere, E. Laping
M. Newcomer. R. Van Berg (University of Pennsylvania)
M. Baron (Sun Valley High School), S. Polgar (Lower Merion High School & Harriton High School)

The purpose of our experiment was to reconstruct a two-dimensional muon path. We used two scintillators to determine when the muon hit, and four chambers of proportional drift tubes filled with dirty argon gas. These would tell us how far the muon passed from the center of a chamber. These distances were processed by computer programs that drew radii corresponding to the distances, and drew a line of best fit from the points that were tangent to the circles. Finally, the line of best fit was analyzed, and an r-squared value was determined. Unfortunately, we did not have enough time to actually collect good data from this experiment due to bugs in the hardware. However, we made significant progress on both the reliability of the hardware and the efficiency of the software. We are sure that next year's group should be able to see muons.

C. Bove, K. C. Chang, W. Giguere, E. Laping
W. Kononenko, G. Mayers, M. Newcomer, R. Van Berg (University of Pennsylvania)
M. Baron (Sun Valley High School), S. Polgar (Lower Merion High School & Harriton High School)

The purpose of our research at University of Pennsylvania was to work on an ongoing project to build a muon-tracking device. The end goal is to link multiple muon-tracking devices from different QuarkNet centers around the country to track particle showers from high-energy particle collisions in the upper atmosphere. The particle detector would track particles using 64 proportional drift tubes in four chambers to give us a 3D line where the particle should have passed. Two scintillators were placed above and below the chambers to give us coincidences that would tell us when a particle should have passed through the four chambers. We were unable to collect data by the end of the program due to electronic chip failure and faulty proportional drift tubes, but spent our time repairing and replacing the tubes as well as building a new data acquisition board for the chambers. Next year's group will be tasked with repairing faulty chip channels that we found during the last week of our program, and with completing the 3D graphing program, we started to provide a visual of where the particle tracks were in the chambers.

C. Bove, K. C. Chang, W. Giguere, E. Laping
M. Newcomer, R. Van Berg (University of Pennsylvania)
M. Baron (Sun Valley High School), S. Polgar (Lower Merion High School & Harriton High School)

Our QuarkNet team continued work on a detecting apparatus for the detection of high-energy cosmic rays, specifically, muons. Muons originate from the upper atmosphere when a cosmic ray collides into an air molecule and decays into products such as muons. Because muons are products from another cosmic source, a large network of cosmic ray detectors can detect a muon shower, which is caused by a concentration of cosmic ray activity. The device consists of two scintillator panels connected to photomultiplier tubes that can detect the passing of a charged particle. In between the two panels, which are oriented above one another, are four aluminum chambers which each house sixteen proportional drift tubes. Two chambers are oriented in the "Y" direction and two are oriented in the "X." The proportional drift tubes are vented with argon gas, and a voltage is applied so that ionization, which occurs due to a charged particle passing through the gas, can be detected. This allows a muon track to be found, potentially in three dimensions, when a muon passes through the device, and our instruments detected the trails of ionization in the proportional drift tubes. When we repaired problems and started the detector, the data indicated that some tubes were triggering constantly, concealing the tubes that were properly indicating a muon hit. This means that in order for the detector to function, the problems with our sensing equipment must be diagnosed and repaired. Next year, the QuarkNet group will focus on eliminating the electrical noise in the system so that the computer can properly record the detector to create the three-dimensional tracks in a Java program.

C. Bove, K. C. Chang, W. Giguere, E. Laping
M. Newcomer, R. Van Berg (University of Pennsylvania)
M. Baron (Sun Valley High School), S. Polgar (Lower Merion High School & Harriton High School)

The purpose of our research was to build an ionizing radiation detector that would detect cosmic rays and modify programs to determine and measure their relative path and energy; we compared our results to the known data of subatomic particles and determined if our cosmic rays were muons. For our detector, we arranged sixty-four proportional drift tubes into four chambers with two rows in each. We placed two chambers (2 and 4) facing the same direction, separated by vertical length; the two other chambers (1 and 3) were set up in the fashion but orthogonal to the previous two chambers (2 and 4). A scintillator paddle was placed above the highest chambers and below the lowest chambers, respectively. Current flowed through the wires located in the center of the proportional drift tubes; similarly, an argon/carbon dioxide gas mix flowed through the proportional drift tubes. We collected data from two of the four chambers every time scintillators showed coincidences; non-coincidental hits were thrown out. We employed the data and converted it into two-dimensional or three-dimensional diagrams. After analyzing the data, we found that there were problems with the hardware and the respective code. Our results show the consistency in malfunctioning tubes and noise interference.

Future research can use this apparatus to narrow the mass range of the Higgs boson particle as well as find potential families of Higgs bosons. Future research can also specify the chambers for other uses, such as time projectors. However, for those using an apparatus similar to ours, advancements are needed to reduce noise and increase sensitivity. Further work is needed for future QuarkNet students working on this research project. As we shift our data collection from two dimensions to three dimensions, coding for the three-dimensional diagrams has to be updated. In addition, future students should focus on the hardware programs and fine-tuning the apparatus.